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By C. N. Pershin

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-USSR-

[Following is the translation of an article entitled "Bakteritsidnyye i fungitsidnyye sredstva" (English version above) by Prof G. N. Pershin in Meditsinskaya sestra (Medical Nurse), Vol 19, No 4, Moscow, April 1960, pages 7-12.]

Agents which kill bacteria are called bacteri ides and those which destroy fungi are called fungicides. When one speaks of an agent which kills micro-organisms indiscriminantly (bacteria, fungus, virus, etc.), he speaks of an agent having microbicidal or germicidal action.

Bactericidal and fungicidal agents ahve varied uses. In the national economy they are used to safeguard various products, materials, and manufactured items from ruin and spoilage through microbial activity. In medicine they are used as disinfectants and antiseptics. By disinfectation is meant the extermination of pathogenic micro-organisms in the ambient air. By antiseptic is meant the use of microbicidal agents for the local treatment of suppurative wounds and for preserving foodstuffs, medical compounds, etc. For disinfectation it is important to destroy the microbes: the essential objective of antiseptics is to stop their reproduction.

The same agents, depending on conditions, can kill the microbes and/or cause the end of their growth and reproduction without direct destruction (microbiostatic or germicidal action).

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The strength of action of germicidal agents depends on a series of conditions. First of all, various micro-organisms have varied sensitivities to various agent. The concentration of the agent is of great significance: with increasing concentration the strength of action of the agent increases. A low concentration is germistatic, though in high concentration it is, as a rule, germicidal in action. At increasing temperatures in the medium microbicidal action increases. The longer the time of action (exposure) of the agent, the stronger the effect. The presence of albumin in the media and also some other organic products lessens the activity that is exhibited by the germicidal preparations.

Microbicidal agents have various mechanical effects on micro-organisms, depending on the chemical and physio-chemical properties of the agent. The microbicidal effects of acids, alkali and salt compounds depend the degree of dissociation: well-dissociated agents have stronger effects. Microbicidal action of other agents depends on their ability to lower the surface tension. Germicidal and dermatophytic functions of salts of many metals and some of the other agents depend on the ability to bind mercaptan groups (-SH) of the substance of microbial cells.

Antiseptic and disinfectant agents subdue the activity of many bacterial ferments. A close parallel is established between the bactericial action of agents and their ability to suppress the dehydrating action of the bacteria. Under the antiseptic influence, the division process is disrupted and begins a morphological disturbance of the microbial cells.

For the evaluation of the strength of the microbicidal effects of various agents a determination is made of their minimum germicidal and germistatic concentrations. On the basis of this comparison of concentrations the activity of the agent is judged.

Microbicidal activity is customarily expressed as the phenolic coefficient of the agent; under it is understood the relationship of bactericidal concentration to the bactericidal concentration of the given agent in the form of a ratio.

For the evaluation of microbicidal agents their toxic effect is of great significance. For medical practice the more significant agents are those that under the more varied of circumstances have the minimum toxic effect on animals and humans.

Let us examine individual groups of microbicidal agents.

HALOGENS

Chlorine and agents containing active chlorine, that is, chlorine easily liberated as a free gas, have a strong bactericidal action. A chlorine concentration of 0.02 mg per liter causes rapid destruction of various microbes. In a medium rich in organic matter the bactericidal function of chlorine is lessened. One must bear in mind that chlorine ions, also chlorine atoms, firmly combined in the organic and inorganic compounds do not have the above-mentioned action. Chlorine and compounds containing active chlorine are reactive chemical agents. Thus they destroy and bleach tissues, causing corrosion also of metals and other undesirable changes in items of use.

Chlorine compounds are used in the purification of water, toilets, excavated holes, buildings, daily items of use, and the treatment of hand and abscessed wounds.

Practical uses exist for gaseous chlorine (the chlorination of water), calcium hypochlorite (mainly for outdoor disinfection), chloramine (external disinfection, treatment of hands and abscessed wounds), pantotsid (the disinfection of individual water supply, disinfection of hands, irrigation, and the treatment of wounds, also in contraceptives), and antiformin (the sterilization of contagious materials in laboratory practice).

Free iodine has a strong microbicidal effect. The phenolic coefficient of iodine equals 180-230. Iodine acts on various micro-organisms and has an especially strong influence on pathogenic fungi.

Iodine is widely used in surgical practice for first aid to wounds, for treatment of the area involved in operations and for the surgeon's hands, and for curing skin infected by fungi. Iodine is irritating to the tissues. In some cases it causes chemical burns of the skin. Iodine is used as a solution in alcohol (5-10 % tincture of iodine) or as an aqueous solution with the addition of potassium iodide (Lyugol' solution). Iodoform, an iodine compound, was used widely in the past as an antiseptic. On contact with the tissues iodoform liberates free iodine that effects the antiseptic action. At present it is seldom used because of

its strong persistent odor.

OXIDANTS

Among the oxidants used are peroxide, potassium permanganate and potassium chlorate. The first two of these compounds are used as antiseptics in the treatment of wounds and for gargling in the throat. Peroxide is easily broken down by the catalase of the tissues into oxygen and water; thus, it produces bubbles of gas on contact with the wound tissues, blood, and pus.

ACID AND ALKALIES

Among microbicidal agents there are various inorganic and organic acids: sulfuric, chromic, boric, acetic, trichloric, undecylenic, benzoic, salicylic, amygdalic and some others. Acids are used mainly as antiseptic agents. Many acids act not only on bacteria but also on fungi. This applies particularly to boric, salicylic, and undecylenic acids. The last-named, in combination with its copper salt and parachlorophenol ester glycerine, is used to treat fungus infection as a salve called undecene (see below).

Among the alkalies the important ones are caustic lime, ammonium hydroxide, soda, and borax. Caustic lime is used inthe form of milk of lime for outdoor disinfection and lime-water as astringent and antiseptic agents; externally, in the event of burns and other inflamed conditions; internally, as regards dysentery. Ammonium hydroxide is used in soaking dirty linen and for treatment of the surgeon's hands before operating. It is useful not only as an antiseptic but as a detergent. Soda and borax are used as weak antiseptics and cleansing agents of mucous fluid from mucous membranes.

COMPOUNDS OF HEAVY METALS

Compounds of heavy metals have microbicidal effects. In acting on the skin and mucous membranes of the human being they act as astringent, irritating and cauterizing agents. Some compounds of aluminum, lead, bismuth, copper, zinc, mercury, and silver are antiseptic and disinfecting agents.

In this group of disinfectants are mercuric chloride and dowcide. Mercuric chloride has a strong bactericidal function; however, its activity sharply declines in the presence of albumin and some other organic matter. Also, mercuric chloride badly irritates the tissues and causes corrosion of metal objects. Lowcide consists of a mixture of ethanol, mercuric chloride, and cetyl pyridine bromide, having strong bactericidal and detergent properties. It is used for fast treatment of the surgeon's hands before operating and also for sterilization of suture materials, instruments, and apparatus. Antiseptic agents are: basic aluminum (Burov's fluid) alum, basic lead (lead water), bismuth tribromocarbolate, dermatol, copper sulfate, copper citrate, zinc sulfate, basic mercuric cyanide, amino mercuric chloride (white precipitated mercury), yellow oxide of mercury, silver nitrate, prolargol, and collargol.

ALCOHOLS

Among alcohols as disinfectant and antiseptic agents there are to be found either ethanol or tartaric alcohols. The more efficient concentration is 70 %. At higher concentrations alcohol, by precipitating albumin, forms a protective coating around the microbe, preventing the access of the alcohol to the interior of the cell.

ALDEHYDES

Formaldehyde is the more important of the aldehydes, since it has a strong bactericidal effect. Formaldehyde -- a gas with an acrid, irritating smell -- is soluble in water. Its 40 % water solution is called formalin. Formaldehyde is used as a disinfectant in solution form as well as gaseous (paraformaldehyde disinfection). For the latter purpose, a solid formaldehyde polymer is used -- paraform -- which, upon heating with water and acids, forms formaldehyde. Urotropine, a formaldehyde compound, and ammonium hydroxide are used in treating abscesses, the central nervous system, and the urinary tract. In those parts of the organism, where acid media is present, urotropine dissociates, forming ammonium hydroxide and formaldehyde. The latter produces the bactericidal action.

PHENOLS

Phenols have a strong bactericidal action. As disinfectants phenol (benzophenol) or carbolic acid, cresol, creolin, parachlorophenol, pentachlorophenol, and hexachlorophen are used. Carbolic and cresol (as lysol), and creolin are used in external disinfection. Hexachlorophen is used in the manufacture of disinfectant soap intended for disinfective treatment of hands; as antiseptic agents phenol, usorcin, atyonol, and tricresyl are used.

PRODUCTS OF DRY DISTILLATION OF ORGANIC MATERIAL

Tar is obtained from the dry distillation of various trees (pine, birch, beech, juniper, etc.). The trees contain intricate mixtures of compounds. Among them are hydrocarbons and phenols. Tars have an antiseptic and an anti-inflamatory effect.

Ichthymol is a product of shale pitch, resulting from dry distillation of certain types of shale. Ichthymol has antiseptic and anti-inflamatory effects. Al'bikhtol has analogous qualities.

DYES

Many dyes have antibacterial functions. Because of their high cost, they are not used for external disinfection but for antiseptic purposes. The more commonly used are brilliant green, rivanol, trypaflavin, methyl blue, and gentian violet, which is also called methyl violet or pioctanin.

FURAN DERIVATIVES

Among furan derivatives the best known for its bactericidal property is furazolin. It is successfully used for the local treatment of abscesses. It is also used for treating bacterial dysentery.

8-HYDROXYCHOLINE DERIVATIVES

From this group of compounds quinosol and yatren are used as antiseptics. Quinozol is also used as a contraceptive.

SURFACE-ACTIVE AGENTS

Surface-active agents have cleansing, foaming, and emulsifying properties. Occasionally, this group is also classified as detergents. The members of the group are divided into cationic, anionic, and non-ionic. The first two divisions have microbicidal effects. The more active are the cationic agents. The above-described dowcide contains in composition a surface-active agent and cetyl pyridine bromide.

ANTIBIOTICS FOR EXTERNAL USE

Antibiotics are so-called because they are antimicrobic, produced by micro-organisms. Among antibiotics are agents used as chemical therapeutic agents for curing infectious illnesses by general application. But some antibiotics cannot be used for this purpose due to their high toxicity and are used as antiseptic agents for local applications (treatment of abscessed wounds, etc.). To the list of the antibiotic group belong geamicidin, kolimitsin, micrccidine and usnic acid.

PHYTCCIDES

Many complex plants produce volatile and non-volatile substances with microbicidal characteristics and provide natural immunity to the plants against micro-organisms. These substances were named phytocides. Volatile phytocides are related to ester oils and for a long time were used as antimicrobic agents.

From phytocide groups, as antimicrobic agents there are used compounds from the garlic plant, onions, St. John's Wort (hypericum perforatum), burnet (poterium sanguisorba), eucalyptus, and several other plants.

ANTI-FUNGI AGENTS

Fungicidal effect belongs to many of the above-examined agents (iodine, boric acid, phenol, cresol, resorcin, beta-naphthal, salicylic acid, ichthymal, tar, mercuric and copper salts, sulfur, and many others). Now, it is in order to pause and consider a bit more in detail the agents that are used as special fungicidal agents. To these belong undecylenic acid, its copper and zinc salts, alpha-parachlorophenol glycerin ester,

salicylanilide, and asterol.

Agents for the treatment of fungi infection are usually given in the form of special salves and powders containing combinations of fungicidal agents. To these compounds belong undecene (a salve containing undecylenic acid, its zinc salt, salicylanilide, and a salve base), and dustandan (a powder containing undecylenic acid, undecylenic zinc, anilide of salicylic acid, and talc).

Fungicidal agents intended for general use for the purpose of curing general infections are very few. Of this group one deserves mention -- antibiotic nyctateme, that finds use for local as well as for general treatment of infections caused by yeasty fungi.

Naturally, in the scope of a journal article we could only briefly touch on the subject. More detailed information of the afore-mentioned substances can be found in specialized reference books.

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